EMTiming Installation Procedure and Checkout for the CEM

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This note describes the installation and checkout of the CEM portion of the EMTiming system. The highest priority is safety of the already working central calorimeter; so all installation work on the detector itself will be done by people approved by Dervin and under his instruction and supervision. We have put into writing a chronologically detailed and pictorial description of the procedure, pointing out the potential trouble spots and other places to be particularly careful of. While great pains will be taken during the installation to ensure nothing is broken, we have also detailed the set of checks the TAMU group will perform before and after every single half-wedge installation to test if the installation adversely affects any other detector system; allowing any problems to be caught and fixed in real time. The procedure is iterative: check CEM systems, install half-wedge and check CEM systems before proceeding. We have listed the items that have the highest probability of being damaged and identify for each who will be called. In the case of a problem the experts will be called upon to fix the damage and they, the installers, the SPLs/operations and us will re-evaluate the procedure before proceeding. Section 1 describes the before and after testing as well as the first steps if there are any problems, Section 2 describes the installation itself and Section 3 shows more pictures of the parts which are most sensitive to being disturbed during installation itself.

Section 1
Before and After Hardware System Checks

(Work done by TAMU group)

Verification checkout schedule: before and after each half-wedge installation.

Texas A&M People: Slava Krutelyov (630-218-8916, FNAL x2120), Sung-Won Lee (FNAL x6647), Max Goncharov (630-476-0774, FNAL x2120); all have ACE training.

System Experts: in event that a problem is detected the experts for the affected system will be called immediately. In addition, we will contact the hardware SPL's (Larry and Willis). The individual system experts to be called are:

CEM LED fibers	Robert Wagner, Larry Nodulman
CEM Xenon fibers	Steve Hahn, Isamu Nakamura
Hadron laser quartz fibers	Fotis Ptohos, Fabio Happacher
CEM PMTs	Larry Nodulman, Robert Wagner
CHA PMTs	Fotis Ptohos, Fabio Happacher, Nikolay Luzhetskiy
CES, CCR & CPR	Karen Byrum, Mike Lindgren, Steve Kuhlmann

Upon detection of any problem we will stop the installation until the experts for the affected system and the acting SPL give the ok for the installation to proceed.

While working on the CEM the installers will come close physically to several calorimeter systems that are sensitive to being bumped. For each system we have identified the most likely failure mode as well as many lower probability but more problematic failures, as well as the fixes and fix times for them. These are identified in more detail in our risk assessment note that can be found at **http://hepr8.physics.tamu.edu/hep/emtiming** . Here we proceed with our description of how those problems will be found; the next two sections show pictures of the hardware and detail the procedure that minimizes the probability that these problems occur.

While every effort will be to touch things as little as possible, each system needs to be checked both before and after the installation of any half-wedge. The systems are: Xenon fibers, LED fibers, Hadron laser quartz fibers, ShowerMax crates and cables, Hadron and CEM PMTs, cable trays, and high voltage cables. For each we will perform the standard calibrations and take cosmics overnight in order to make sure that we have not affected any of them. All the calibrations are standard and the output data is stored in the database and can be easily accessed through the DBANA database interface; any differences are easily identified. To perform calibrations and take cosmics we need a running DAQ system. It is expected that the system will be available with the exception of 3 days scheduled (from Frank Chlebana) for the system upgrade. We will do the following (summarized in Table 1):

1. CEM LED calibration: This checks whether the CEM LEDs and LED fibers are intact, the PMT high voltages are well connected, and that the PMTs are working and reading out correctly. This calibration takes normally less that 2 minutes, with 10 minutes required to access the database through DBANA. The most likely failure is a broken fiber, PMT or cable connection and in this case Bob or Larry should be called. In either case, the fix is straightforward and not overly time-consuming.
2. CEM Xenon calibration: For our purposes this is the same as above except it for it doesn't check the LED system, but it does checks whether CEM Xenon fibers and system are intact and whether the wave shifters have been damaged. It takes less then 5 minutes with 10 minutes needed for database access. It is very unlikely we will break a Xenon fiber, but in case there is some problem Steve Hahn should be called.
3. CHA laser calibration: This checks the CHA quartz fibers, CHA PMT high voltage, and CHA PMT functionality and readout. It takes ~30 minutes to run the calibration and 10 minutes to check it with 10 minutes to access data through DBANA. The most likely failure here is a broken CHA PMT, cable connection or laser fiber. If this occurs, Fotis or Fabio should be called. In either case the fix is straightforward. In the fiber case, there are minimal spares and the actions outlined in the risk document apply.
4. ShowerMax Strips, Wires, CPR and Crack Chamber calibrations: This QIE test checks from the input of the ShowerMax crate through the readout path and tests for any cables which might be knocked loose during the installation. The standard calibration takes ~10 min plus 10 minutes to access the database. The most likely

problem is that the create readout cables get bumped. In this case Karen, Mike or Steve should be called. The fix is typically painful but straightforward and is usually estimated to be about ½ hour once the fixer is able to get to the cables.

5. Cosmic Ray overnight runs: Since the ShowerMax tests only checks the crate and the path from the crate to the DAQ, we will run cosmics overnight and look at the occupancy plots for the Strips, Wires, CPR and Crack Chambers. We are in the process of working with Steve Kuhlmann to update his diagnostic software that was used for checkout during the main Run IIa installation. The same comments as in the ShowerMax system calibration test apply here as well.

The 4 calibrations are standard and are currently performed by the DAQ ACE on shift on a regular basis; we have 3 persons with ACE training to run them (Sung-Won Lee, Slava Krutelyov, and Max Goncharov). The whole set takes approximately 1 hour. We are going to perform the calibrations before and after every half-wedge installation. For each of the calibrations there is a standard way in DBANA to determine if there are changes in the system. Running cosmics overnight to the Look Area can be the standard operating procedure for the control room and can be run by the shift crew. If any changes in any of the systems occur, the system experts will be called and the installation will be stopped to evaluate why a particular failure happened. The installation of a single wedge (Section 2) takes much more time than the full set of calibrations, so we have enough time to catch failures in real time.

Calibrations:	**Components:**					**Time**
CEM LED	CEM PMT	High Voltage	LED Fibers	Cables	Readout	~15min
CEM Xenon	CEM PMT	High Voltage	Xenon Fibers	Cables	Readout	~15 min
CHA Laser	CHA PMT	High Voltage	Quartz Fibers	Cables	Readout	~30 min
ShowerMax	Crate				Readout	~15 min
Cosmic Rays	Strips & Wires	CPR	Crack Chamber	Cables	(Readout)	~8 hours (overnight)

Table 1: Calibration – System hardware map. Here “Cables” means the cables that connect from the detector component to the boards in the readout crate. By Readout we mean the cables from the crate to upstairs (Crate, ADMEM, long cables).

Section 2
Harness Installation on the Detector Itself

List of people approved for installation work: Jamie Grado and Lew Morris (FNAL), Fabio Happacher, Andrea Sansoni, Giovanni Bisogni, Mario Anelli, and Marco Cordelli (Frascati)

The installation consists of two main parts: Laying the splitter harnesses[1] on the wedges and running them from the wedges in the cable trays to the relay racks. Only people approved and trained by Dervin (listed above) will do the installation. Each crew consists 2 persons under his instructions and supervision, and they are to work with safety and carefulness (rather than speed) being their highest priority. In this section we detail the installation steps as well as point out the potential danger spots. Dervin's estimate is ~3 wedges/day, and double this time for wedges on top and at the bottom assuming we can get to them. Section 3 provides more pictures about some of the more sensitive parts that require extra attention during installation.

The installation is to be done in groups of 3 wedges with each wedge within a group having a different length/type. See Table 2. The groups are (by order of length within the group) 0-1-2, 5-4-3, 6-7-8, 11-10-9, 12-13-14, 17-16-15, 18-19-20 and 23-22-21. Each group's cables are routed in the cable trays to a focal point where they are run to the relay rack. See Table 3. By installing in groups we minimize the access time to the cable tray and to the relay rack. Even though each harness is individually labeled, Table 2 should be used as a cross check. First we install the easiest wedges to access (see Figure 1 for details). The proposed order is: North-East groups of wedges 23-22-21, 0-1-2; North-West groups 23-22-21, 0-1-2; South-East group 12-13-14, 11-10-9; South-West group 12-13-14, 11-10-9. We note that the order is somewhat arbitrary[2], and should be modified to accommodate which wedges can be most safely accessed at the time. Installing the cables on the wedges can be staggering with running the harnesses in the cable trays if needed. After the easy wedges to access, the difficult wedges at the top and at the bottom are installed: 3-4-5, 6-7-8, 20-19-18, and 15-16-17.

Initial Setup

- Bring a coiled CEM harness to the cable tray (see Figures 2 and 3) near the wedge being installed.
- Remove the wedge metal cover.
- Unwind the harness from the split point (where the left and right sides of the harness split for the two wedge sides); leave the part that goes into the cable tray coiled for now.
- Fix the coiled part to the cable tray with a cable tie at a convenient spot.

At this point you have a coiled part of the harness attached to the cable tray and two separate cable bundles of 10 RG174 cables with splitters on the ends, one bundle for the

[1] 20 RG174 cables with splitters on one end.
[2] Although there are physics benefits to installing wedges 23 and 0 early on.

left and one for the right side. You are now ready to install the individual splitters on the wedge itself. Pictures and diagrams of the wedge and how the cables will be in the final layout are shown in Figures 2-4.

Laying the cable for a half-wedge

- Put the square cable tie holders (~4/half-wedge)[3] along the edge of the wedge metal plate (on the base side of the PMTs) at the same distance from each other starting at CEM PMT 8 as shown in Figure 3.
- Separate the two sides (left and right), and bring one up and around the Pisa Box to the metal plate.
- Lay the half-harness along the cable tie holders and fix loosely with cable ties as shown in Figure 3. **Danger Point:** **It is important to not apply pressure on the lemo or HV connectors attached to the bases of the PMTs** (Figure 7) **or reach too far past the base of the CEM or CHA PMTs where the fibers are located.**

Connecting the PMTs (after laying the harness on a half-wedge).

Starting with PMT 9 to make sure the cables do not pull and lay flat along the metal plate:

- Unattach the longest of 10 cables from the harness and bring it close to the CEM PMT base. Do not unwind it from the nearest cable tie if it is not necessary.
- Disconnect the CEM PMT anode RG174 cable LEMO connector and reconnect it to the female LEMO connector on the splitter, see Figure 4.
- Connect the short RG174/LEMO connector end of the splitter to the CEM PMT anode.
- Repeat the above steps for CEM PMT 8 through 0.
- Tighten the cable ties at the end of the job.

Finishing the wedge

- After installing a half-wedge do testing (see Section 2) and if everything is ok install the second half-wedge.
- Put the wedge metal cover back in place.

After the whole group of 3 wedges is installed start unwinding the coiled type 0 harnesses (the longest one) and lay the cable in the cable tray. Unwind it towards its focal point (again see Table 3) and the type 1 harness. Combine the two harnesses and unwind both towards the type 2 harness and the focal point. Combine all three and bring to the focal point. From the focal point bring them all together to their respective Relay Rack and Crate (again see Table 3) as in Figure 5. After this is done the LEMO connectors on the cables are attached to the transition board as described in the *Cable and Mapping Note*[4] and dressed in the cable trays and at the relay rack.

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[3] Number is somewhat arbitrary.

[4] See http://hepr8.physics.tamu.edu/hep/emtiming/cablemap

Type 0	Type 1	Type 2
Wedges 0,5,6,11, 12,17,18,23	Wedges 1,4,7,10, 13,16,19,22	Wedges 2,3,8,9, 14,15,20,21

Table 2: Wedge number – Harness type map. Different wedges have different distances to the relay rack. For example, Wedge 0 (type 0) has a different path length from the end of the wedge to the focal point before going to the relay rack, as detailed in Table 3.

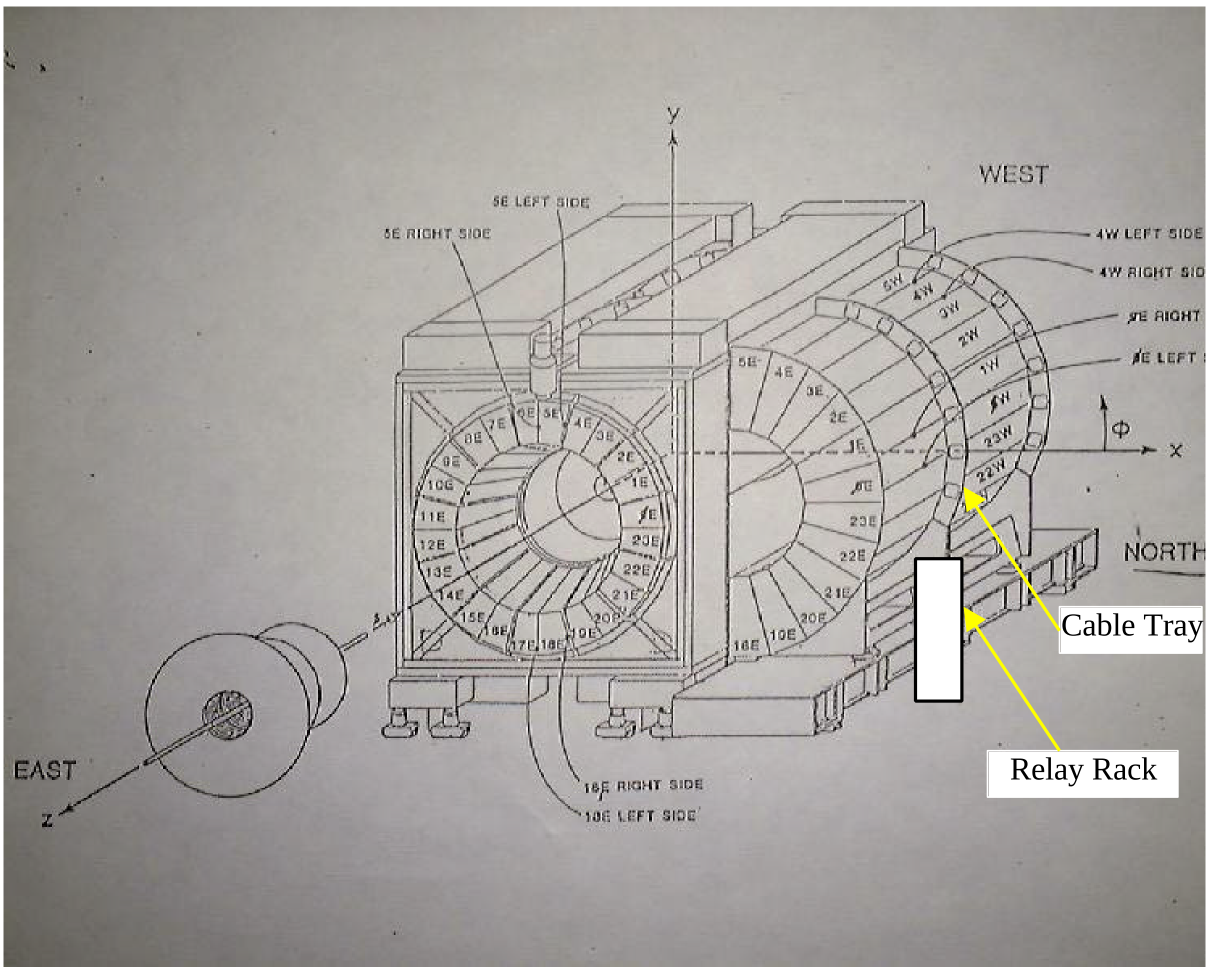

Figure 1: Detector Layout.

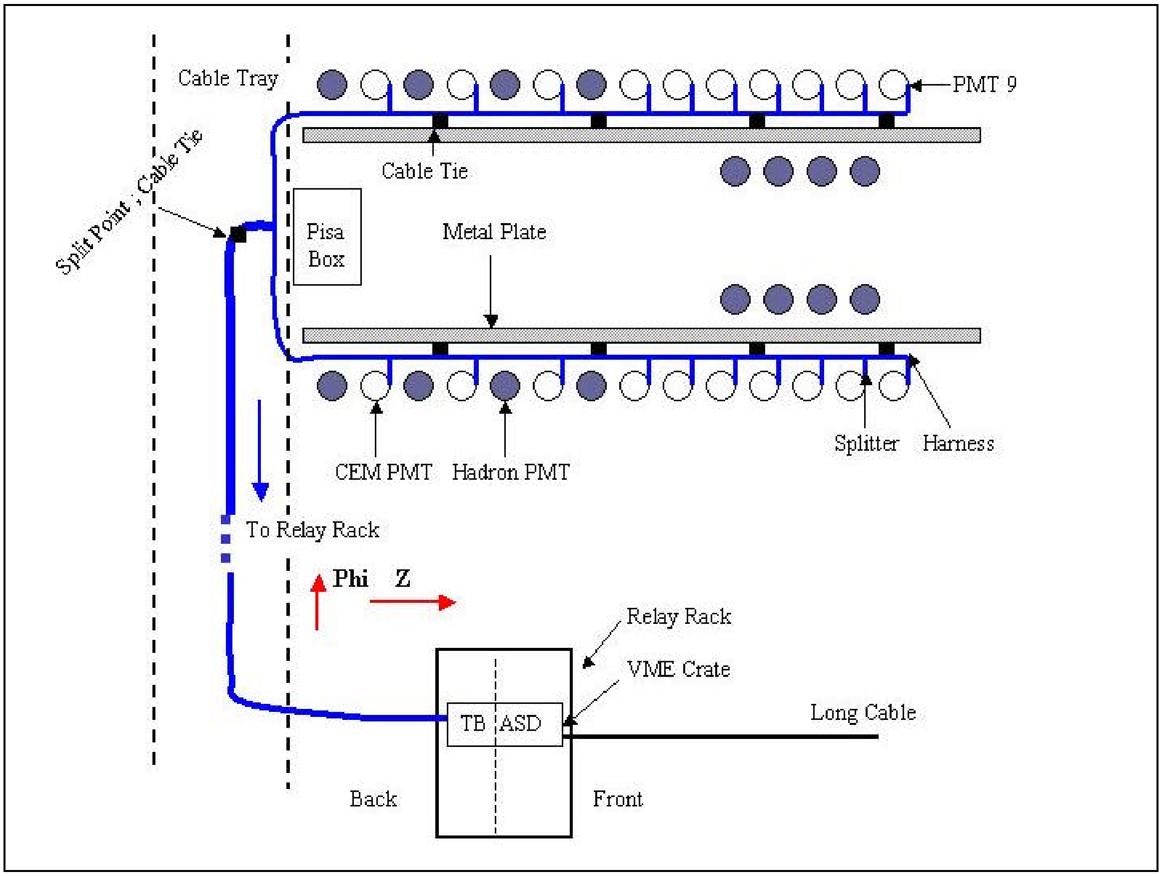

Figure 2: Schematic layout of the Splitter harness on the detector.

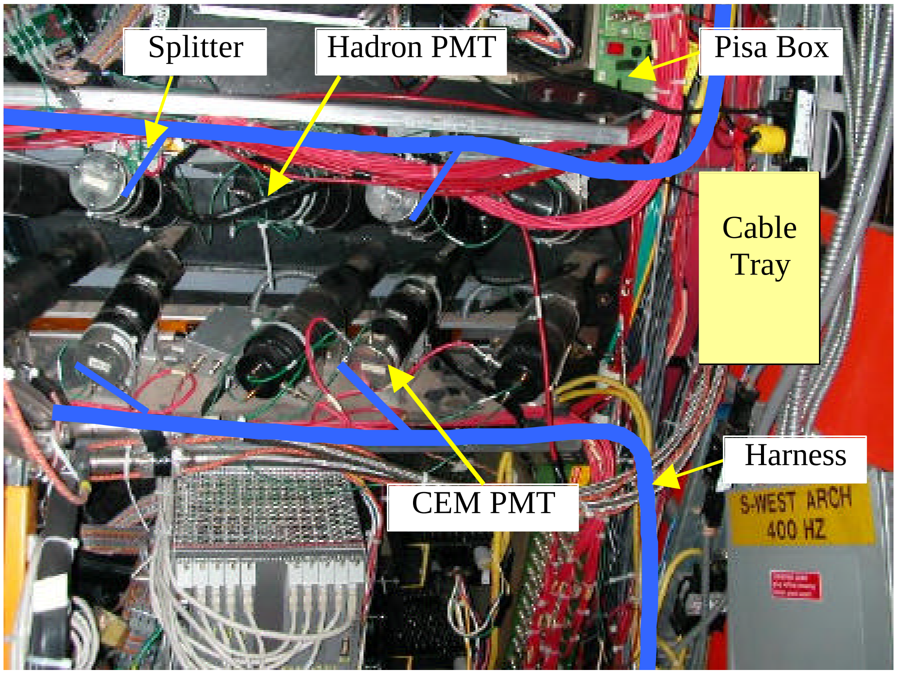

Figure 3: A wedge splitter harness (in Blue) installed on two separate wedges. The harness goes from the cable tray, around the Pisa Box and onto the metal plate where it is attached with cable ties to cable tie holders. On the plate the splitters go into the CEM PMT bases (silver base) and bypass the CHA PMTs (black base). Installation happens away from sensitive fibers that are connected to PMTs faces (facing the center of the detector as shown in Figure 6).

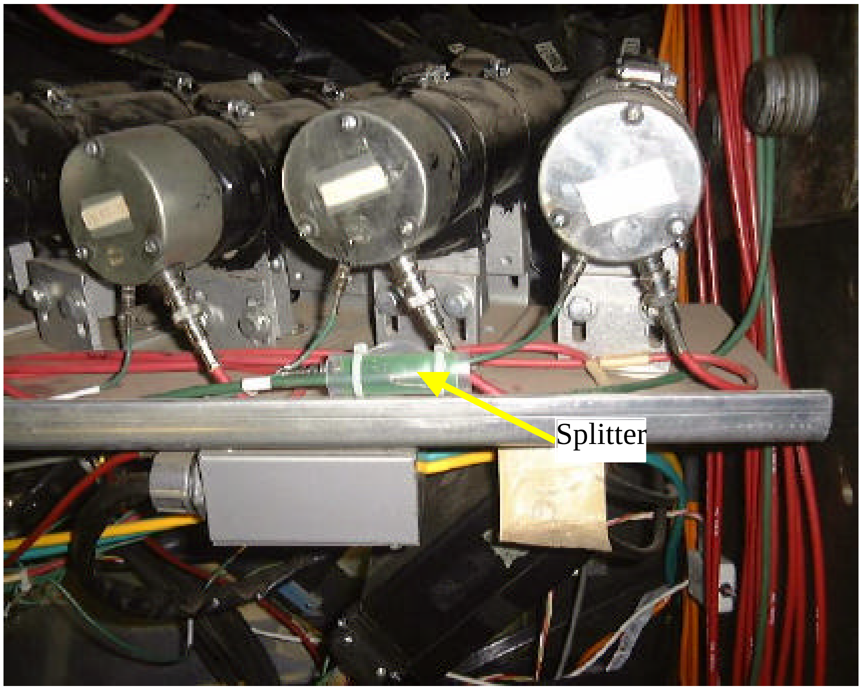

Figure 4: A splitter hooked up to CEM PMT 9. The harness lies in the metal plate as shown.

Figure 5: The harness coming from the focal point in the cable tray and going into the transition boards in the relay rack.

Wedge #	Cable Tray Focus Point	Relay Rack-Crate
00	Between wedges 2&3 (up)	NT-T
01	Between wedges 2&3 (up)	NT-T
02	Between wedges 2&3 (up)	NT-T
03	Between wedges 2&3 (down)	NT-T
04	Between wedges 2&3 (down)	NT-B
05	Between wedges 2&3 (down)	NT-B
06	Between wedges 8&9 (up)	ST-T
07	Between wedges 8&9 (up)	ST-T
08	Between wedges 8&9 (up)	ST-T
09	Between wedges 8&9 (down)	ST-T
10	Between wedges 8&9 (down)	ST-B
11	Between wedges 8&9 (down)	ST-B
12	Between wedges 14&15 (up)	SB-T
13	Between wedges 14&15 (up)	SB-T
14	Between wedges 14&15 (up)	SB-T
15	Between wedges 14&15 (down)	SB-T
16	Between wedges 14&15 (down)	SB-B
17	Between wedges 14&15 (down)	SB-B
18	Between wedges 20&21 (up)	NB-T
19	Between wedges 20&21 (up)	NB-T
20	Between wedges 20&21 (up)	NB-T
21	Between wedges 20&21 (down)	NB-T
22	Between wedges 20&21 (down)	NB-B
23	Between wedges 20&21 (down)	NB-B

Table 3: The route for each harness from the wedge to its focal point along the cable tray, and eventually to its final relay rack and crate destination. In Rack-Crate notation SB-T stands for the South-Bottom relay rack, Top crate.

Section 3
More Pictures of the Most Sensitive Parts on the Detector

This section shows more close up photographs of the following sensitive parts to assist in understanding where the danger points lie. We highlight the Xenon fibers, LED fibers, Hadron laser quartz fibers, ShowerMax electronics, Hadron and CEM PMTs, cable tray, high voltage cables, and the wedge metal plate.

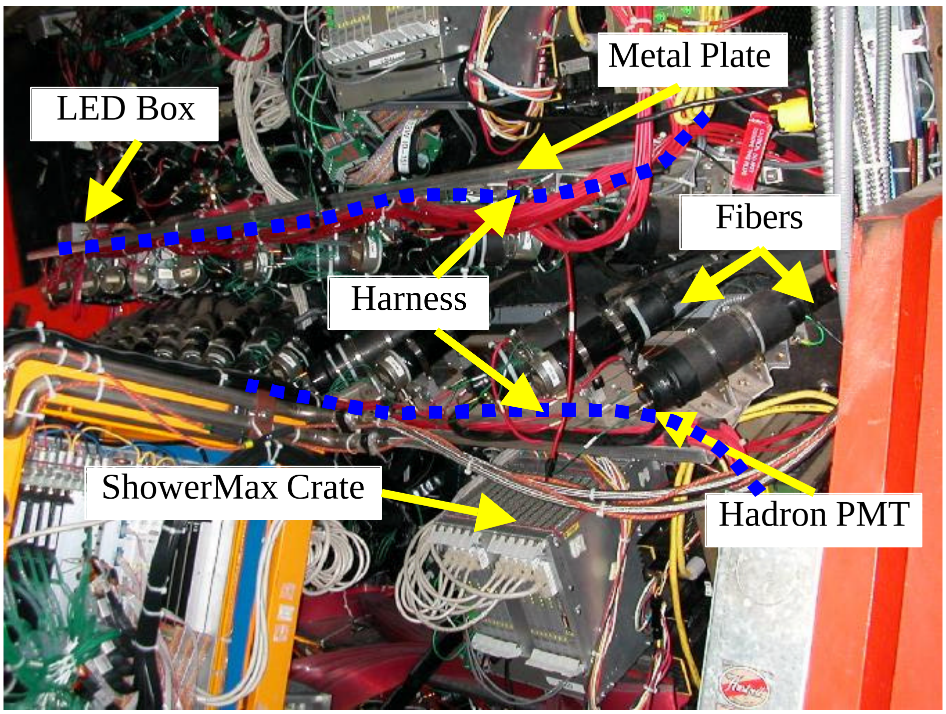

Figure 6
Metal Plate: may not be used as a weight support. ShowerMax Crate: the danger here is nudging cables loose that go into the crate. Hadron PMT: the harness goes near the LEMO connectors and HV cables, so one must be extra careful not to damage them. LED Box: physically we stay away from it during installation. Fibers near the PMT face: very brittle, hard to fix. Installation happens near the bases, while fibers connect to PMTs from the face.

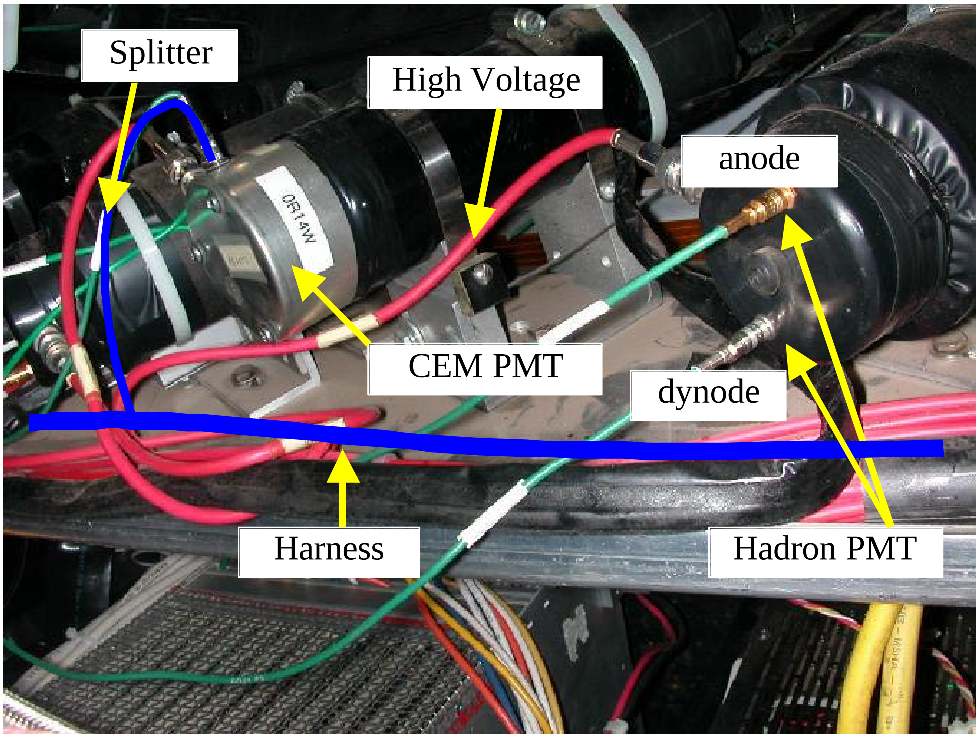

Figure 7
Close-up view of the Hadron PMT base with HV, dynode and anode outputs in front of the base. It also shows the harness (in Blue) along the metal plate.

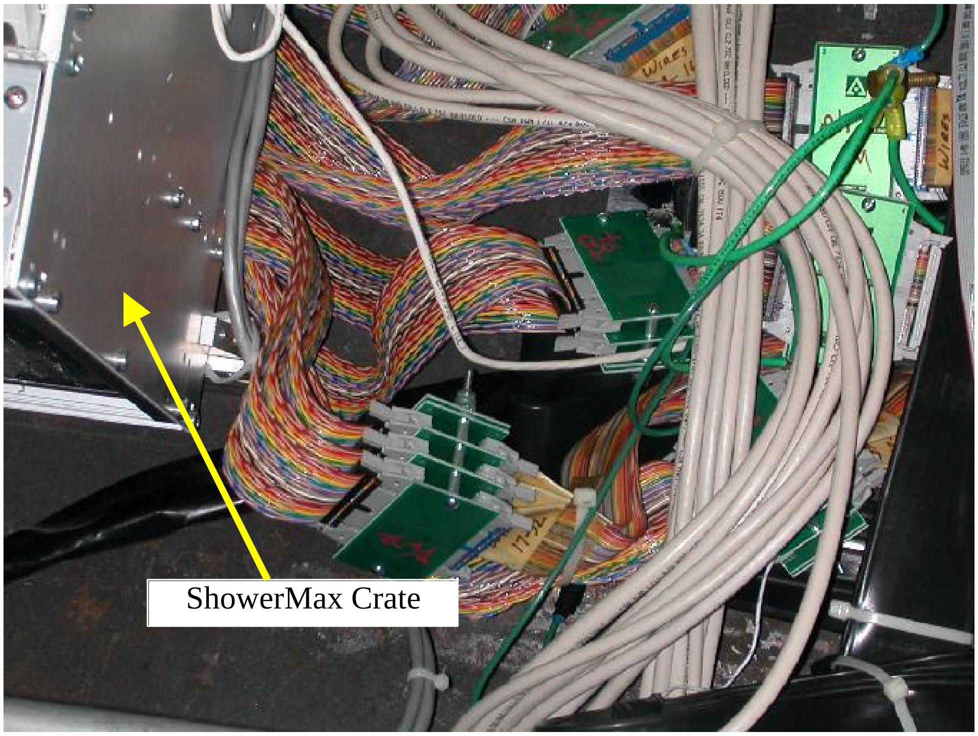

Figure 8

ShowerMax Electronics: the cables that are shown are very tight. It would take at least ½ hour to reconnect them (once you reach the wedge) if the ShowerMax calibrations indicate that they have accidentally become loose. Figure 6 shows where the crate sits in the wedge.